Dialysis Practices That Distinguish Top- Versus Bottom-Performing Facilities by Hemoglobin Outcomes

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Background: Because there is wide variation in outcomes across dialysis facilities, it is possible that top-performing units use practices not shared by others. The Identifying Best Practices in Dialysis (IBPiD) Study seeks to identify practices that distinguish top- from bottom-performing facilities by key outcomes, including achievement of recommended hemoglobin targets.

Study Design: Observational study with cross-sectional study ascertainment of predictors and outcomes.

Predictors: Facility dialysis practices ascertained using practice surveys of dialysis staff who indicated their level of agreement that each practice occurs in their facility (1-6 on a Likert scale).

Setting & Participants: 423 personnel in 90 dialysis facilities from 1 for-profit and 2 not-for-profit dialysis organizations.

Outcomes: Percentage of patients per month per facility with hemoglobin levels of 11-12 g/dL. We divided facilities by median into top- versus bottom-performing groups and compared mean scores for each practice using *t* tests. We report practices that were statistically significant and achieved at least a medium effect size (ES) $\geq$0.4.

Results: 17 of 155 tested predictors were significant. Achievement of hemoglobin level targets was related most strongly to the use of chairside computers (ES, 0.8 [95% CI, 0.4-1.4]), extent/quality of educational videos (ES, 0.6 [95% CI, 0.2-1.1]), frequency of calling per diem staff if short staffed (ES, 0.6 [95% CI, 0.21-1.1]), policy that nurses pass written competency examinations before hire (ES, 0.6 [95% CI, 0.2-1.0]), and technician cannulation mastery (ES, 0.6 [95% CI, 0.2-1.1]).

Limitations: This is a cross-sectional study that can address only associations, not causations. Future research should measure the longitudinal predictive value of these practices.

Conclusions: High-performing facilities report more effective education programs, better staff management, higher staff competency, and higher use of chairside computers, a potential marker of information technology proficiency. This suggests that hemoglobin level management is enhanced by processes reflecting a coordinated multidisciplinary environment.

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Although there is controversy regarding how best to manage anemia in dialysis patients,[1] low hemoglobin levels are associated with diminished survival[2-7] and therefore are a key clinical performance measure (CPM) tracked by Medicare.[8] Despite improvements in the use of iron supplementation and higher measured iron levels in dialysis patients over time,[9] there has been little improvement in achievement of recommended hemoglobin level targets.[9,10] Moreover, there is considerable variation in anemia outcomes among dialysis facilities, and this varia-

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tion is not explained merely by differences in dosing of erythropoiesis-stimulating agents.[10]

Although outcome variation is a natural byproduct of variations in patient populations, data indicate that outcome variation in dialysis persists even after case-mix adjustment.[10-12] Thus, there may be other unmeasured facility-level factors or practices affecting these outcomes. It is possible that top-performing dialysis facilities use practices or have characteristics not shared by others.

In collaboration with the Renal Physicians Association and American Nephrology Nurses Association, we initiated the Identifying Best Practices in Dialysis (IBPiD) Study to catalogue and test "best practices" that are associated with improved patient outcomes in dialysis, including achievement of Medicare CPMs.[13] IBPiD is based on the hypothesis that dialysis-related CPMs, such as hemoglobin level, dialysis adequacy, and levels of calcium-phosphorus product, parathyroid hormone, and albumin, fall along the causal pathway between point-of-care practices and downstream clinical outcomes (eg, morbidity and mortality). We hypothesize that by moving "upstream" from the traditional focus of linking clinical intermediates to clinical outcomes and focusing instead on the proximal relationship between point-of-care practices with clinical intermediates, we may identify transferable best practices linked with improved clinical outcomes. If the dialysis community can identify and measure these best practices and ultimately link them to improved outcomes, future efforts can focus on widespread implementation of these high-yield practices to improve overall facility-level outcomes. In this study, we present results from IBPiD pertaining to dialysis practices that distinguish top- versus bottom-performing facilities by achievement of recommended hemoglobin level targets, a key outcome monitored by Medicare.

METHODS

IBPiD Overview

IBPiD is a 3-phase multidisciplinary study to identify best practices associated with facility-level achievement of dialysis CPMs, including maintenance of hemoglobin level targets.[14] The present study reports data from phase 3 of IBPiD. Phases 1 and 2 have been described in detail in a previous publication,[12] which culminated in the development of 155 candidate best practices for dialysis facilities. These were catalogued (Item S1**;** provided as online supplementary material available with this article at www.ajkd.org) and operationalized in a questionnaire designed for use by dialysis organizations to quantify adherence to these practices in their facilities.[13] The primary objective of phase 3, described here, was to test whether the candidate best practices identified and prioritized in phases 1 and 2 predict facility-level outcomes, including achievement of target hemoglobin goals, across dialysis organizations and facilities. The study was approved by the University of California at Los Angeles Institutional Review Board and conducted in accordance with institutional guidelines regulating human subject research.

Questionnaire Administration

Questionnaire Content

We administered confidential online questionnaires to staff in 90 randomly selected dialysis facilities across 3 organizations, including 1 not-for-profit small dialysis organization (Satellite Healthcare), 1 not-for-profit medium dialysis organization (Dialysis Clinic Inc), and 1 for-profit small dialysis organization (Renal Ventures Management LLC). The questionnaire elicited staff perceptions regarding dialysis practices and other facility-level factors developed from our previous work.[13] These included procedural factors (eg, maintaining an intershift "communication log book," actively checking that injectables are administered before taking patients off the machine, and developing formal systems to correct short staffing), structural factors (eg, position of nurse work stations, configuration of pods and computers, and availability of educational materials), interpersonal relationships and staff attitudes (eg, culture of mutual respect, positive and open communication, active problem solving, and enthusiasm), and belief-oriented factors (eg, beliefs about the role of facility-based health maintenance). The questionnaire had 9 sections, including: (1) physician practices, (2) staff working climate, (3) facility characteristics and amenities, (4) facility-based health maintenance practices, (5) technician practices, (6) nursing practices, (7) social work practices, (8) dietician practices, and (9) multidisciplinary conference practices. For each dialysis practice within these sections, respondents were asked to indicate their level of agreement that the practice occurs in their facility, using a 6-point Likert scale (1 = do not agree at all and 6 = agree completely). Frequency ratings also were rendered on a 6-point scale (1 = never and 6 = always). Dichotomous policies and procedures were answered with a binary yes versus no response.

Validating Online Questionnaire Results

Although provider surveys often are a cost-effective way to assess process of care, they potentially are limited because responses may be incongruent with the reality on the ground. On-site assessments can help verify responses of provider surveys. We therefore conducted on-site assessments in a sample of 15 dialysis units from our sample. A trained observer (H.S.) visited the centers and abstracted site data while blinded to performance outcomes of facilities and results of online staff surveys. For purposes of inter-rater reliability, a second trained rater (R.B.) was present during 4 of the visits, and agreement was evaluated using κ statistic for dichotomized assessments. To test the reliability of the online instrument, we measured correlation coefficients across a core set of items embedded in both types of data collection. We measured cross-instrument correlations for a variety of facility physical characteristics (eg, layout of chairs and pods, proportion of nursing stations with direct view of patients, use of computers on wheels), staffing characteristics (eg, staff to patient ratios), and processes of care (eg, hand-washing frequency, glove-changing frequency, and use of aseptic technique). We found that inter-rater agreement was excellent, with κ scores of 0.82-0.89 for the dual-rater visits. Furthermore, correlations between on-site assessments and staff reporting were positive and achieved expected directionality, with most $r = 0.5\text{-}0.7$. Of note, although site visits were useful to evaluate relatively invariant characteristics of the facilities, they could not be used to reliably confirm many staff ratings of patient characteristics, interpersonal relationships, or physician practices, among others.

Sampling

Within each facility, we administered online surveys to staff in 5 roles, including: (1) medical director, (2) nurse manager/supervisor, (3) floor nurse, (4) dialysis patient care technician, and (5) dietician. We developed separate surveys for each staff position that reflected the responsibilities and perspectives of the respondent's role, but also included overlapping questions (eg, perceptions of staff cohesiveness or morale) to help triangulate on variables common to all roles. To ensure that no staff member's personal bias skewed results, each question was asked of staff from at least 2 different positions within the facility. Additionally, for facilities that were large enough, we surveyed 2 nurses and 2 technicians in lieu of focusing on only 1 individual's perception.

Calculation of Facility Item Scores

To minimize the influence of social desirability in the response, a subset of items was asked in the negative. The first step in processing item scores was to reverse the scaling for all these items. To obtain the best unbiased estimate for each item at a facility level, all available responses, independent of staff position, were averaged to arrive at a composite scale score for each question. In instances in which staff skipped items, we imputed data using the mean of available nonmissing items. In instances in which no staff member in a particular role responded to the survey, we were unable to assign item scores to facilities lacking the data.

Statistical Analysis

We sought to identify predictors of facility-level hemoglobin level management, defined as the percentage of patients per month with hemoglobin levels of 11-12 g/dL. The staff survey was conducted between December 2007 and January 2008. We correlated results with hemoglobin outcomes for each facility for the 12-month period directly preceding the survey, as reported by each organization using monthly laboratory data for January through December 2007. Data included all patients treated in the dialysis facilities regardless of insurance status. Hemoglobin level ascertainment included all data reported during the entire year without removal of incident patients.

Because we tested more than 150 predictors of facility-level outcomes, we performed sequential analytic steps to focus our analyses on the most important predictors. First, we divided the 90 participating facilities in top- versus bottom-performing groups, stratified by the median split for hemoglobin outcomes. We then performed bivariate analyses to compare mean facility-level scores for each survey item between groups using *t* test. To generate a parsimonious list of variables and in acknowledgment that statistical significance does not always correspond with clinical significance, we limited our subsequent analyses to predictors fulfilling explicit criteria, including: (1) the difference in scores between top- versus bottom-performing facilities exceeded an effect size (ES) of 0.4 standard deviation (SD; calculated as the difference in mean values in the respective groups divided by the pooled standard deviation), which is considered to be a "medium effect" in clinical studies,[15] and (2) the *P* value for the bivariate relationship was significant at the $P \leq 0.05$ level. By limiting our analysis to parameters that both were statistically significant and achieved a minimum ES threshold, we attempted to guard against spurious and potentially noninformative results.

Because hemoglobin is measured on a continuous scale, we next evaluated the linear relationship between each predictor selected from our initial screen and facility-level outcomes. Using all data from the sample, we calculated a Pearson correlation coefficient between each facility-level item score and facility-level outcomes. For each analysis, we calculated a *P* value for the linear relationship based on a bivariate ordinary least squares regression analysis. We then selected predictors that met criteria for statistical significance and arranged them within the 9 categories listed under Questionnaire Content.

Finally, because the relationship between each predictor and hemoglobin level outcomes may be confounded by a center effect driven by systematic differences among participating organizations, we included an organization variable in the regression models to evaluate for the presence of an organization-level (as opposed to facility-level) effect. We used SAS version 9.0 (www.sas.com) for all analyses.

RESULTS

Sample Characteristics

There were 90 participating facilities across the 3 organizations, including 423 personnel who completed the online surveys (mean age, 44.8 ± 10 years; 19% men; mean tenure, 6.6 ± 6.3 years). Table 1 lists descriptive information about participating units. Figure 1 shows the distribution of hemoglobin level outcomes across the 90 participating facilities. On average, across facilities, 46% of patients per month achieved the hemoglobin level target of 11-12 g/dL (25th, 50th, and 75th percentiles = 39%, 45%, and 52%). Percentages of patients per month with Kt/V ≥1.2, albumin level ≥3.5 g/dL, and parathyroid hormone level of 150-300 pg/mL were 91%, 81%, and 38%, respectively. The standard-

Table 1. Characteristics of Participating Centers

	Renal Ventures, LLC	Satellite Dialysis	Dialysis Clinic Inc
Profit status of dialysis organization	For profit	Not for profit	Not for profit
Size of dialysis organization	Small	Small	Medium
No. of participating facilities	19	24	47
Total no. of staff surveys completed	96	120	207
Age of respondents (y)	43 ± 11	45 ± 11	46 ± 11
Sex of respondents (% men)	18	18	19
Tenure of respondents (y)	6.0 ± 5.7	7.7 ± 7.6	6.5 ± 5.9
Unit size range (no. of patients)	57 ± 21 (range, 15-68)	61 ± 27 (range, 11-201)	78 ± 48 (range, 10-155)
Location of participating facilities	TX, NJ, IA, WV, AK	CA, TX	AL, CA, CT, FL, GA, IN, LA, MO, NE, NJ, NV, NY, PA, SC, TN
Years in operation	≥10	≥30	28

ized mortality ratio across facilities was 0.87 ± 0.4. In staff who completed the survey, only 4% of items were skipped and required imputation. Of 90 participating facilities, 73 had complete case ascertainment from all 5 staff roles. The rest had data from no fewer than 4 of 5 staff roles. There was no difference in staff nonresponse between top- versus bottom-performing groups ($P = 0.5$). Of note, there also were no differences in mean facility size or years in operation between facilities in the top- versus bottom-performing groups.

Predictors of Facility-Level Hemoglobin Outcomes

Of 155 tested predictors of facility-level hemoglobin outcomes, we identified 17 that met criteria for statistical and ES significance. These are listed in Table 2 and are arranged by categories, as described next.

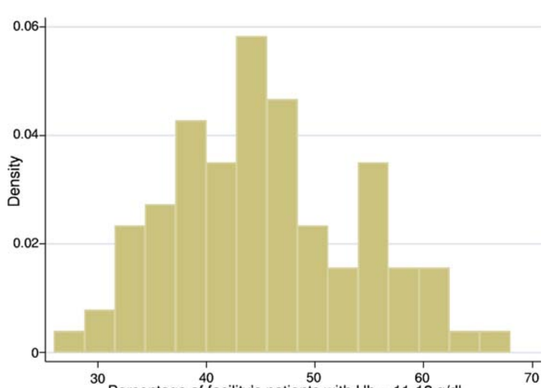

Figure 1. Distribution of hemoglobin level outcomes among 90 participating facilities. The histogram shows normal distribution for the outcome of interest: average percentage of patients per month with hemoglobin levels of 11-12 g/dL. Abbreviation: Hb, hemoglobin.

Nursing Practices

Of the tested nursing practices, hemoglobin level outcomes were related most strongly to: (1) frequency with which management calls in per diem nursing staff when faced with unexpected staffing shortage (ES = 0.6; 95% confidence interval [CI], 0.21-1.1), (2) policy that nurses must pass written competency examinations before hire (ES = 0.6; 95% CI, 0.2-1.0), (3) perceptions that nurses are highly effective in educating their patients about their kidney disease (ES = 0.6; 95% CI, 0.1-0.9), (4) perception that nurses are enthusiastic and energetic about their work (ES = 0.4; 95% CI, 0.05-0.9), (5) staff perception regarding aggressiveness of nurse manager to actively address problems (ES = 0.4; 95% CI, 0.05-0.8), and (6) staff perception that nurses have high level of independence (ES = 0.4; 95% CI, 0.1-0.9). In contrast, hemoglobin level outcomes were not predicted by use of an intershift communication log book, the frequency by which nurses round with physicians, the frequency of nurse audits by supervisors, perceived timeliness of preparing and administering injectable medications, or having a policy to increase erythropoietin doses by a fixed percentage over the prehospitalization dose for patients just returning from the hospital, among other practices.

Technician Practices

Of tested technician practices, outcomes were related most strongly to: (1) the perception that

Table 2. Predictors of Facility-Level Achievement of Hemoglobin Values of 11-12 g/dL Stratified by Domain

Dialysis Practice/Factor	Bottom Half No.	Bottom Half Mean	Top Half No.	Top Half Mean	Pooled SD	Diff Between Means	ES (95% CI)	r	P
Nursing practices									
Frequency by which management calls in per diem nursing staff when faced with unexpected staffing shortage	44	2.42	43	3.25	1.31	−0.83	0.63 (0.21-1.1)	0.361	0.001
Policy that nurses must pass written competency examinations before being hired	39	2.88	37	3.88	1.90	−1.00	0.52 (0.2-1.0)	0.355	0.002
Effectiveness of nurses in educating their patients about their kidney disease	43	4.04	45	4.55	1.01	−0.51	0.50 (0.1-0.9)	0.247	0.02
Level of nurse enthusiasm and energy for their work	42	4.40	42	4.95	1.18	−0.55	0.47 (0.05-0.9)	0.319	0.003
Nurse manager aggressiveness in addressing and solving problems in the facility	41	3.99	42	4.47	1.19	−0.48	0.40 (0.05-0.8)	0.240	0.03
Level of nurse independence	42	4.96	40	5.36	0.94	−0.40	0.43 (0.1-0.9)	0.238	0.03
Technician practices									
Technician mastery/proficiency of vascular cannulation	42	7.59	42	8.20	1.16	−0.61	0.53 (0.2-1.1)	0.334	0.002
Technicians focus less on dialysis machines, more on patients	41	4.68	38	5.06	1.04	−0.38	0.37 (0.1-0.9)	0.275	0.01
Frequency by which technicians leave at least 2 inches of space between bevels in fistulae	41	3.97	38	4.45	1.08	−0.48	0.52 (0.1-0.9)	0.248	0.03
Amount of practice technicians are afforded for vascular cannulation	41	4.53	38	5.09	1.12	−0.55	0.49 (0.05-0.9)	0.230	0.04
Staff working climate									
Ability of managers to create a communal working environment	43	4.14	44	4.54	0.93	−0.40	0.43 (0.03-0.86)	0.241	0.03
Facility characteristics and amenities									
Facility use of chairside computers	38	3%	35	36%	0.38	33%	0.87 (0.4-1.4)	0.554	<0.001
Extent and quality of educational videos available for patients	43	2.27	44	3.01	1.20	−0.74	0.61 (0.2-1.1)	0.384	<0.001
Availability of adequate no. of television sets for patients in the unit	43	4.65	45	5.43	1.33	−0.78	0.57 (0.1-1.0)	0.318	0.003
Availability of modern and up-to-date computer systems	42	4.02	41	4.62	1.29	−0.60	0.47 (0.03-0.9)	0.216	0.05
Facility-based health maintenance practices									
Facility offers patients formal intradialytic exercise programs	38	4%	35	19%	0.30	15%	0.5 (0.01-1.0)	0.235	0.05
Physician characteristics									
Frequency that physicians actively inform the dialysis staff when a hospitalized patient is being discharged with plans to resume treatments in the facility	43	4.51	45	4.94	0.90	−0.43	0.40 (0.02-0.9)	0.19	0.03

Note: Facilities were divided into top- versus bottom-performing using 12-month facility-level hemoglobin level outcomes. The table presents dialysis practices that distinguished between groups using benchmarks for both statistical significance ($P \leq 0.05$) and ES (≥0.4 SD). *P* refers to correlation coefficient. Means refer to Likert scale described in text.

Abbreviations: CI, confidence interval; Diff, difference; ES, effect size; SD, standard deviation.

technicians have high mastery of vascular cannulation technique (ES = 0.6; 95% CI, 0.2-1.1), (2) perception that technicians focus less on dialysis machines and more on dialysis patients themselves (ES = 0.4; 95% CI, 0.1-0.9), (3) frequency by which technicians leave at least 2 inches of space between bevels in fistulae (ES = 0.4; 95% CI, 0.1-0.9), and (4) perception that technicians are afforded extensive practice with vascular cannulation (ES = 0.4; 95% CI, 0.05-0.9). In contrast, hemoglobin level outcomes were not predicted by the perceived skill of technicians for assessing fistulae bruit and thrill, ability to follow aseptic technique, quality of technicians' bedside manner with patients, or the frequency of technician audits by supervisors, among other practices.

Staff Working Climate

Of characteristics of the staff working climate, outcomes were most strongly related to staff perception that managers do a good job of creating a communal work environment (ES = 0.4; 95% CI, 0.03-0.86). In contrast, hemoglobin level outcomes were not predicted by the perceived competitiveness of the staff's salary, among other factors.

Facility Characteristics and Amenities

Of the tested facility characteristics and amenities, outcomes were most strongly related to: (1) facility use of chairside computers (36% vs 3% of top- vs bottom-performing units use chairside computers; ES = 0.8; 95% CI, 0.1-1.4), (2) availability of extensive and high-quality collection of educational videos for patients (ES = 0.6; 95% CI, 0.2-1.1), (3) availability of sufficient number of television sets for patients in the unit (ES = 0.6; 95% CI, 0.1-1.0), and (4) perception that computer systems are up to date and modern (ES = 0.4; 95% CI, 0.03-0.9).

Facility-Based Health Maintenance Practices

Of tested facility-based health maintenance practices, outcomes were associated with only the practice of offering patients formal intradialytic exercise programs (19% vs 4% of top- vs bottom-performing facilities offer a formal program; ES = 0.4; 95% CI, 0.01-1.0). Of note, hemoglobin level outcomes were not associated with the presence of a dedicated anemia manager, as endorsed and defined by the medical director at each unit (86% vs 84% of top- vs bottom-performing units had an anemia manager; $P = 0.5$).

Physician Practices

Of tested physician characteristics, outcomes were predicted by only the frequency by which physicians actively inform the dialysis staff in advance when a hospitalized patient is being discharged with plans to resume treatments in the dialysis facility (ES = 0.4; 95% CI, 0.02-0.9).

Nonpredictive Domains

Facility-level hemoglobin level outcomes were not predicted by any of the tested social work or dietician practices (eg, knowledge, enthusiasm, or patient rapport) or multidisciplinary conference practices (ie, frequency, timing, or composition of multidisciplinary conferences).

Organization-Level Effect

We evaluated for evidence of an organization-level effect on the observed relationships. However, the organization variable was not significant as a predictor of hemoglobin level outcomes in each of the regression models. The identified predictors remained significant despite adjusting for organization.

DISCUSSION

Despite the dissemination of the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines,[16] data indicate that adjusted hemoglobin level outcomes vary considerably among US dialysis facilities.[10] Fink et al[10] found that intercenter variations in hemoglobin level management are independent of erythropoiesis-stimulating agent dosing, suggesting there are nonpharmacologic processes that influence overall hemoglobin level outcomes. It is possible that top-performing facilities enact specific practices that bottom-performing facilities do not enact. In this study, we sought to identify best practices that may account for variations in hemoglobin level outcomes between top- and bottom-performing centers.

We identified 17 modifiable and potentially transferable practices that distinguished top- versus bottom-performing units. Because these practices were identified in a cross-sectional sample, their relationship to hemoglobin level outcomes is merely associative, not necessarily causal. Nonetheless, it is worth noting that these practices cover a wide range of domains, including nursing practices, technician practices, staff working climate, facility characteristics and amenities, and physician practices. This raises the hypothesis that hemoglobin level management may be enhanced by care processes that reflect a coordinated multidisciplinary environment; in other words, no single group, practice, or characteristic will solely drive facility-level hemoglobin level outcomes. Understanding and improving hemoglobin level outcomes likely will require a holistic view of the dialysis facility.

We found that facility-level hemoglobin level outcomes are related strongly to characteristics of patient educational programs. Specifically, top-performing units had more extensive higher quality collections of educational videos and a higher staff perception that nurses are effective in educating their patients versus bottom-performing units. Although not directly tested in this study, it is possible that effective educational materials may lead patients to identify changes in their health status that lead to a decrease in hemoglobin levels. In addition, it is possible that the impact of educational materials is different in dialysis facilities compared with other health care environments because patients in dialysis units are a captive audience; dialysis patients may take more time to review, interpret, and act upon educational advice compared with patients in other clinical environments. Although our study did not parse the detailed characteristics of patient educational programs in top-performing units, our data suggest that future research should identify components of educational programs that drive achievement of CPMs such as hemoglobin level. Moreover, these findings raise larger issues about the role and impact of educational programs, including whether the presence of an effective program might become a CPM worth monitoring and tracking.

We found that hemoglobin level outcomes were predicted by the use of chairside computers and the perceived modernity of computer systems. Whereas 36% of top-performing units report using chairside computers for order entry and data management, only 3% of bottom-performing units follow this practice ($P < 0.0001$). Although it is unlikely that the mere presence of chairside computers can independently drive facility-level hemoglobin outcomes (ie, the relationship is not causal), use of chairside computers may be a surrogate marker for overall information technology proficiency and possibly enhanced use of hemoglobin algorithms. Anemia management is complex, with multiple factors determining the achieved hemoglobin level, including patient characteristics (sex, race, comorbid conditions, and the presence of inflammation), biochemical status (adequacy of dialysis and iron stores), and dosing of erythropoiesis-stimulating agents. Use of chairside computers may improve the speed and accuracy with which changes in hemoglobin levels or iron stores can be translated into appropriate changes in management and thus improve hemoglobin level control. Another hypothesis is that use of information technology in the facility increases the likelihood that adequacy targets will be achieved by making key data readily availability for timely and evidence-based decisions.

In contrast, hemoglobin level outcomes were not predicted by the presence of a dedicated anemia manager, a staff position developed for the express purpose of monitoring and actively improving hemoglobin level outcomes. Coupled with data that outcomes are predicted by overall staff competency and enthusiasm, these findings suggest that information technology sophistication and global staff attributes may drive hemoglobin level outcomes more than an individual staff member. The practical implication for dialysis managers is that assigning a dedicated anemia manager may be necessary, but probably is insufficient to improve hemoglobin level outcomes. There also should be a more global effort to enhance information technology proficiency, maximize staff competency (eg, requiring nurses to pass written competency examinations before being hired and providing extensive opportunities for technicians to practice cannulation skills), and provide high-quality patient education.

Regarding staff competency, there are several mechanisms that might explain the relationship between nurse and technician skills and hemoglobin level outcomes. Nurses are relied on to understand and follow protocols written by physicians. This is particularly true of anemia management, for which protocols drive erythropoiesis-stimulating agent and iron administration. More competent nurses are more likely to understand the need to follow the protocols closely, including timely review of laboratory results and dose adjustments. We also hypothesize that poorer technician cannulation might lead to more blood loss with cannulation and removal of needles and more failed accesses, leading to more catheters, which in turn lead to poorer anemia management.

We found that personnel in top-performing facilities perceive a higher quality of overall staff management. Specifically, top units are more likely to call for per diem help if there is unexpected short staffing, have nurse managers who aggressively and proactively solve problems, have better perceived staffing levels, and cultivate a communal respectful work environment. If a facility is short staffed, timely review of laboratory results and administration of injectable drugs is one of the first things to suffer. The major priority of staff is to start and stop dialysis treatments in a safe and timely manner. If injectables are missed or dose changes are not made in the course of a short-staffed environment, poorer anemia control is inevitable.

We found a series of practices that may jointly enhance dialysis adequacy. These range from enticements for patients to come to their appointments (eg, sufficient availability of televisions sets), "value-added" programs to stay in their chairs (eg, intradialytic exercise programs), and ensuring high-quality vascular access (eg, following recommendations for distance between bevels in fistulae and ensuring that technicians have mastered cannulation techniques). This again emphasizes that hemoglobin level outcomes are associated with a variety of best practices across the facility. Of note, we previously reported predictors of Kt/V in our cohort and found that personnel in units achieving high Kt/Vs report more effective staff communication (eg, using intershift communication log books), enhanced staff management (eg, having policy to call in per diem staff if unexpected short staffing), less staff turnover, enhanced coordination of care (eg, performing multidisciplinary conferences soon after patients are discharged from the hospital), more frequent medication reconciliations, and improved cannulation skills compared with lower performing units.[17] There was overlap with a few categories of the hemoglobin level predictors identified in the present study; namely, frequency of calling in per diem staff and technician cannulation mastery. However, many of the predictors do not overlap. This is consistent with the finding of Spolter et al[18] that correlation between hemoglobin level outcomes and dialysis adequacy is imperfect, suggesting that distinct processes probably determine quality for each performance measure. Our results suggest that some process may be associated with both outcomes, whereas others may be specific for one versus another.

Our analysis has limitations. First, this is a cross-sectional study; therefore, we can comment on only associations, not causations. Future research should measure the longitudinal predictive value of these practices. Second, although we used a comprehensive approach to identify candidate best practices in phases 1 and 2 of the IBPiD,[13] it is likely that key clinical elements nonetheless are missing. Third, we relied on staff reporting about practices in their facility. It is possible that staff perceptions may not be wholly accurate. However, we triangulated using multiple perspectives so that the principle of regression to the mean should tend to stabilize biases from any particular group. Fourth, there were many instances of missing data from nonresponse. Although this could introduce bias, it is hard to predict the direction because nonresponders were randomly distributed across facilities. Fifth, we did not explicitly measure use of hemoglobin algorithms, including automated computer-based protocols. It is possible that use of algorithms and other anemia-related treatment practices might vary among organizations and facilities and could confound comparisons. Nonetheless, because variations in hemoglobin level management appear independent of erythropoiesis-stimulating agent dosing,[10] it is unlikely that algorithms alone drive wide variations in outcomes; this could be empirically studied in future research.

An additional limitation is that the newest Centers for Medicare & Medicaid Services (CMS) performance target for hemoglobin is 10-12 g/dL, which replaces the older target of 11-12 g/dL used in this study. Because our study covered a period when the CMS target was 11-12 g/dL and the summary data collected and provided from participating organizations used the older target, we relied on the range of 11-12 g/dL for this study. Nonetheless, the old and new targets are highly collinear by mathematical necessity because 11-12 g/dL is fully contained within 10-12 g/dL. Thus, the same set of predictors would be expected to predict both overlapping outcomes. Nonetheless, this is an acknowledged limitation of the study. It also is important to note that the CMS hemoglobin level target changed to 10-12 g/dL starting in 2008 and our survey was completed in late 2007 to early 2008; in other words, during an overlapping period as the hemoglobin level target changed. It is possible that some units already may have been moving toward this new target in 2007, which potentially could undermine the reliability of our findings.

In conclusion, we found that high-performing facilities report more effective education programs, better staff management, higher staff competency, and higher use of chairside computers, a potential marker of information technology proficiency. This suggests that hemoglobin level management may be enhanced by processes reflecting a coordinated multidisciplinary environment. These data may help dialysis managers focus their efforts on improving hemoglobin level outcomes by addressing modifiable practices enacted by top-performing units.

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SUPPLEMENTARY MATERIAL

Item S1: Candidate Best Practices Perceived to Improve Outcomes in Dialysis Facilities.

Note: The supplementary material accompanying this article (doi:10.1053/j.ajkd.2010.02.346) is available at www.ajkd.org.

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